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Discrimination between ictal EEG and EMG activity based on digital EEG

Norihiko Kawaguchi, Kiyohito Terada, Yukitoshi Takahashi

National Epilepsy Center, Shizuoka Institute of Epilepsy and Neurological Disorders, NHO, Urushiyama 886, Aoi-ku, Shizuoka, Japan

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Time-frequency analysis is used to detect high-frequency components on intracranial and scalp EEG (Kobayashi *et al*, 2010; Zijlmans *et al*, 2017). However, analysis programs are not always available in clinical situations. We introduce a method to detect high-frequency components without special analysis programs. EEG activity shows sinusoidal waveform with stable / evolving frequency and stable / evolving amplitude. On the other hand, electromyogram (EMG) is sharply contoured with variable frequency and variable amplitudes because EMG is a summation of numerous motor units. Digital EEG enables us to distinguish EEG from EMG based on clarification of these characteristics by magnifying time scale and amplitude scale (*figure 1*). This method is simple and applicable in clinical situations. □

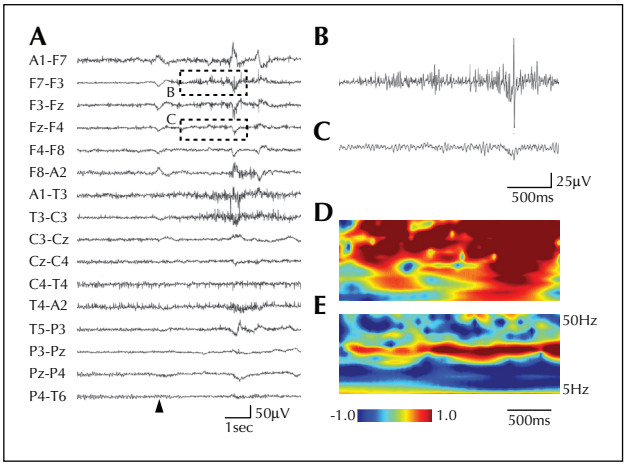

Figure 1. (A) Ictal EEG of a 63-year-old male patient with right frontal lobe epilepsy on transverse montage (LFF: 1.6 Hz, HFF: 120 Hz). The patient moves both hands over his head at the onset of the seizure (the arrow head indicates clinical onset). It is difficult to differentiate between the EEG and EMG. The waveforms in dotted boxes are shown in (B) and (C), with enlarged time window and amplitude, and limited low-frequency filter (LFF: 5.3 Hz). (B) The EMG demonstrates sharply contoured activity with varying amplitude. (C) The EEG shows the sinusoidal waveform with regular / evolving amplitude. (D, E) Time-frequency analysis demonstrates distinct patterns on the EMG and EEG ([D] and [E] correspond to [B] and [C], respectively). The sharply contoured EMG activity results in a power increase within a broad range of activity in (D), and the sinusoidal EEG activity is represented as the increase of power at around 20-30 Hz (E). The power spectrums are normalized to baseline (duration: 1 second, 6 seconds before the seizure onset) (wavelet analysis in Wide-band EEG Analysis, NIHON KODEN).

Supplementary data.
Summary didactic slides are available on the www.epilepticdisorders.com website.

Disclosures.
None of the authors have any conflict of interest to declare.

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Correspondence:
Norihiko Kawaguchi
National Epilepsy Center,
Shizuoka Epilepsy and Neurological Disorders,
NHO, Urushiyama 886,
Aoi-ku, Shizuoka, 420-8688, Japan
<nr.kawaguchi@gmail.com>

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TEST YOURSELF

(1) Which of the following are important when analysing waveforms on an EEG recording?
A. Frequency filter
B. Time scale
C. Amplitude scale (sensitivity)
D. Montage

(2) What are the characteristics of an EEG (brain activity)?
A. Sinusoidal waveform
B. Non-sinusoidal, sharply contoured waveform
C. Regular amplitude and stable frequency
D. Variable amplitude and variable frequency

(3) Which of the following is NOT true regarding the sampling rate and frequency filter?
A. The sampling rate is recommended to be more than three-fold higher than the high-frequency filter.
B. If the sampling rate is very low, the waveforms are distorted.
C. Digital EEG can change the sampling rate after the recording.
D. Digital EEG can record a broader range of activity than analogue EEG.
E. Applying the frequency filter changes the waveforms on EEG.

Note: Reading the manuscript provides an answer to all questions. Correct answers may be accessed on the website, www.epilepticdisorders.com, under the section "The EpiCentre".